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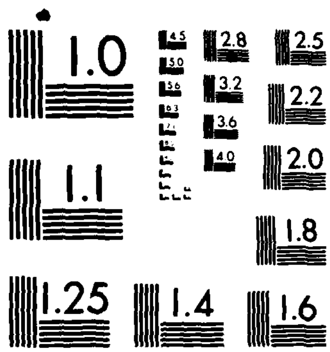
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ESL-TR-85-21

# Timer Rinse Control Systems

1LT JAMES R. ALDRICH
CHARLES G. ROBERTS

USAF ENGINEERING AND SERVICES LABORATORY (AFESC/RDVW)



SEPTEMBER 1985

FINAL REPORT

JANUARY 1985 - JUNE 1985

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

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# REPORT DOCUMENTATION PAGE

| | |
|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>UNCLASSIFIED | 1b. RESTRICTIVE MARKINGS |
| 2a. SECURITY CLASSIFICATION AUTHORITY | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Approved for Public Release.<br>Distribution Unlimited. |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br>ESL TR 85-21 | 5. MONITORING ORGANIZATION REPORT NUMBER(S) |
| 6a. NAME OF PERFORMING ORGANIZATION<br>USAF Engineering and Servies Laboratory (AFESC/RD)<br>6b. OFFICE SYMBOL (If applicable)<br>RDVW | 7a. NAME OF MONITORING ORGANIZATION |
| 6c. ADDRESS (City, State and ZIP Code)<br>HQ AFESC/RDVW<br>Tyndall Air Force Base, Florida 32403 | 7b. ADDRESS (City, State and ZIP Code) |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>8b. OFFICE SYMBOL (If applicable) | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State and ZIP Code) | 10. SOURCE OF FUNDING NOS. |

| PROGRAM ELEMENT NO. | PROJECT NO. | TASK NO. | WORK UNIT NO. |
|---|---|---|---|
| 64708F | 2054 | 70 | 39 |

11. TITLE (Include Security Classification)
Timer Rinse Control Systems

12. PERSONAL AUTHOR(S)
1st Lt James R. Aldrich, Charles G. Roberts

| 13a. TYPE OF REPORT | 13b. TIME COVERED | 14. DATE OF REPORT (Yr., Mo., Day) | 15. PAGE COUNT |
|---|---|---|---|
| Final | FROM Jan 85 TO Jun 85 | September 1985 | 44 |

16. SUPPLEMENTARY NOTATION
Availability of this report is specified on reverse of front cover.

| 17. COSATI CODES | | | 18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |
|---|---|---|---|
| FIELD | GROUP | SUB. GR. | Rinse control, electroplating waste, industrial waste, electroplating, electroplating rinse tanks. |
| 13 | 02 | | |

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Timer rinse control systems were installed on eight rinse tanks at the San Antonio Air Logistics Center (SA-ALC) electroplating shop to evaluate their use for reducing water consumption at military metal finishing facilities. The controllers achieved a 71 percent reduction in water consumption for the eight tanks tested. The economics of applying the controllers, installed cost approximately $1000 per unit, is site-specific and dependent upon factors such as initial water use rates. Although SA-ALC does not use enough water to justify a complete change over to the new system, most military metal-finishing facilities would benefit from the system. Included in the report is a predictive model for system application.

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|---|---|
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br>UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐ | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>JAMES R. ALDRICH, 1Lt, USAF | 22b. TELEPHONE NUMBER (Include Area Code)<br>(904) 283-2942/3<br>22c. OFFICE SYMBOL<br>HQ AFESC/RDVW |

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## PREFACE

This report was prepared by the Air Force Engineering and Services Center, Engineering and Services Laboratory, Tyndall Air Force Base, Florida, under Job Order Number IESC 0008, Timer Rinse Control Evaluation. Data from project resulted in a generic model for determining the applicability of timer rinse control systems to military plating shops.

This report covers work performed between January 1985 and June 1985. The work was done via a research and development contract with L. I. Dimmick Corporation, Reston, Virginia. The AFESC Project Officer was 1Lt James R. Aldrich.

This report discusses the results of testing a particular timer rinse control system for reducing the volume of water used at Air Force electroplating facilities. The report does not constitute an indorsement or rejection of any specific piece of equipment for Air Force use nor can it be used for advertising a product.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public including foreign nationals.

This technical report has been reviewed and is approved for publication.

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Director, Engineering and Services Laboratory

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## SECTION I

## INTRODUCTION

### OBJECTIVE

The objective of this project was to evaluate a manually activated, timed flow controller for reducing the volume of rinse water used in metal finishing operations.

### BACKGROUND

As part of aircraft maintenance, the Air Force operates five major electroplating facilities at its Air Logistic Centers (ALCs). These facilities generate over 1 billion gallons of wastewater which must be treated at an industrial waste treatment plant (IWTP) at an annual cost of over $3 million (Reference 1).

Nearly 90 percent of this wastewater comes from the rinse systems in the plating shops due to a constant flow of approximately 3 to 15 gallons per minute to each tank. However, the plating workload at the ALCs is highly variable with most process tanks only being used intermittently. As a result, the continuously flowing rinse tanks pour clean water into the waste stream which increases treatment costs, lowers the pollutant concentrations in the wastewater, and requires unnecessarily large treatment plants.

### SCOPE

This project shall evaluate timed, rinse control systems at the San Antonio Air Logistics Center (SA-ALC). Water use data on the tanks selected for the demonstration shall form the basis for a predictive model for applying this technology.

## SECTION II

## PRESENT RINSE CONTROL TECHNOLOGY

### THEORY

Factors effecting rinse efficiency include agitation within the rinse tank, the concentration of metal in the rinse water, and the amount of time the part is immersed. These three variables must all be considered if effective rinsing is to be maintained. The first is the variable under consideration, the time the part is in the tank is largely a function of the production rate of the shop, and the concentration of meta_s a quality control item. In turn, the water flow can be minimized by optimizing these variables.

The relationship between the concentration of metals in a plating bath and it's associated rinse tank is referred to as the rinsing criterion, "R." Assuming the rinse tank is completely mixed (i.e., air-agitated), "R" is defined as:

$$R = Cp/Cn \tag{1}$$

where Cp = metal concentration in the plating bath and
Cn = maximum allowable metal concentration in the rinse water.

If solution dragout on the part being rinsed (D) is included, the amount of water needed to keep the rinse tank free of metals (Q) can be calculated:

$$Q = D\ (Cp/Cn). \tag{2}$$

For example, if a part and its rack drags out .05 gallons (D) from a plating bath with 18 ounces/gallon of solution (Cp) and is rinsed in a finishing rinse tank with a maximum allowable metal concentration of .01 ounces/gallon (Cn) the required rinse water flow (Q) can be calculated:

$$Q = .05 \times (18/.01) = 90 \text{ gallons per part.}$$

If the average rinse water flow to this example tank was average, 10 gallons per minute, this tank could rinse 6 parts per hour. However, given the intermittent nature of the operation at the ALCs (approximately 1 to 2 parts per hour), up to 3 million gallons of water could be needlessly added to the wastewater flow.

### CURRENT TECHNOLOGY

Countercurrent Rinsing.

Countercurrent rinsing uses multiple rinse tanks with the water flowing opposite to the flow of the workpieces. By reusing the water from the last tank to the first, even a two-stage system can reduce water consumption by as much as 90 percent (Reference 2).

Although the capital investment for countercurrent rinsing is relatively high, this is a common technique in private industry where the workload is constant. However, due to the intermittent workload and the space requirement for extra rinse tanks, the ALCs would not benefit from this technology.

Rinsewater Reuse.

This technique involves reusing water from one rinse tank for another that either has a less stringent contaminant requirement or a complimentary use (e.g., reuse alkaline rinse water as feed for an acid rinse). This technique is effective at reducing water flow, but has major drawbacks. First, great care must be taken to not mix acidic rinse water with cyanide processes. Second, it requires a great deal of complex plumbing to incorporate. Finally, once the system is installed, it restricts plating/rinse tank use if changes are required.

Flow Restrictors.

These devices reduce the flow to the rinse tank by reducing the diameter of the inlet water pipe. Although these devices are widely used by both military and private industries, they are designed to benefit operations requiring continuous flowing rinse tanks. Again, the intermittent workload limits their benefit to military operations.

Conductivity Cells.

A conductivity cell measures the concentration of dissolved solids in the rinsewater. When the concentration gets to a preset maximum, the freshwater flow is started and continues until the solids concentration is diluted to a preset minimum. Theoretically, these devices are ideal for both the military and private industries because they are dependent only upon the concentration of the contaminants in the rinsewater; however, there are inherent problems. First, the controllers are frequently packaged in a metal box which is subject to corrosion problems. Second, since the probes are located in the rinse water, they are subject to damage by the workpieces as they are rinsed. Finally, the platers can easily override the systems by placing the probes in the plating tank causing a continuous flow.

SECTION III

# TIMER RINSE CONTROL

## TECHNOLOGY DESCRIPTION

Timer rinse controls are manually activated to deliver a preset quantity of water. The flow is determined by using Equation (2). These systems can be activated by either pushbutton or contact switch in the case of automatic plating lines. A typical system is shown in Figure 1.

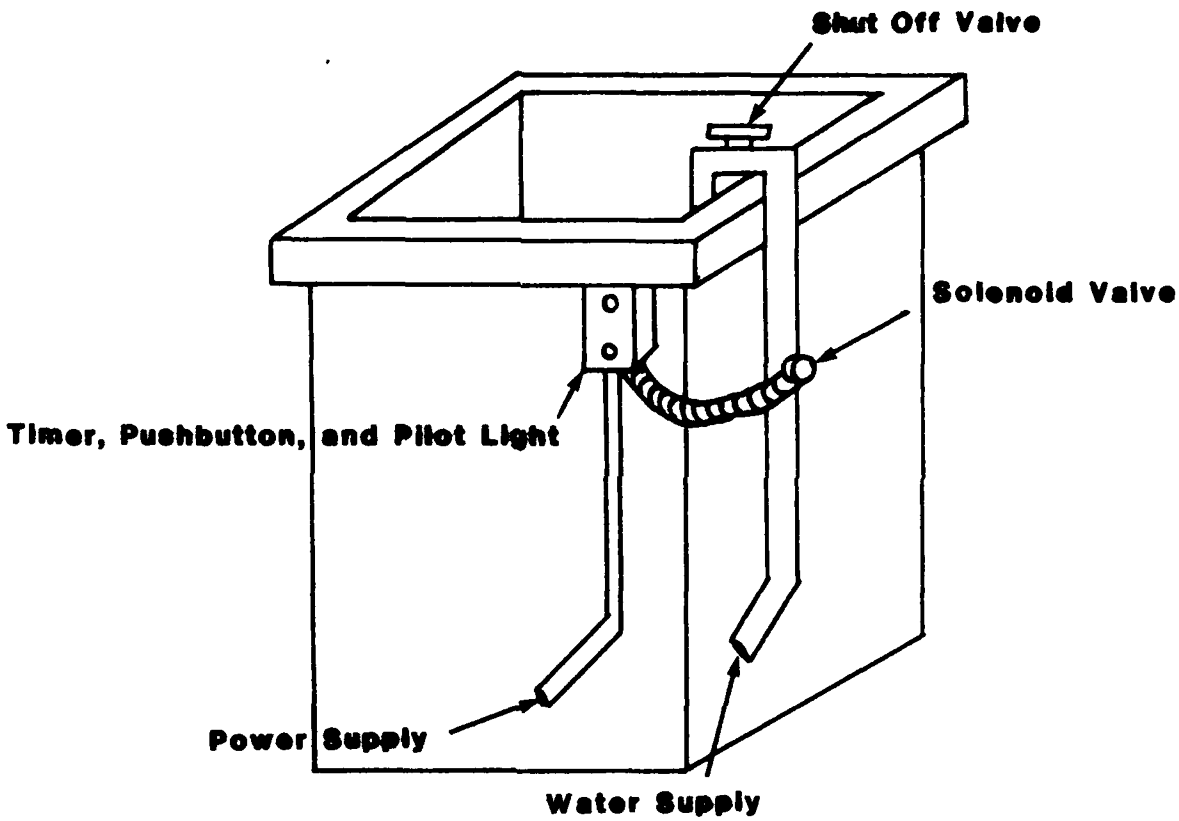


Figure 1. Timer Rinse Control System.

The biggest advantage of this system to the military is that it is tailored to intermittent use. The flow is activated only when a part is rinsed and because the control box must be disassembled to change the timer setting, it is very difficult to override.

## EQUIPMENT DESCRIPTION

The system designed for the SA-ALC is manually activated consisting of two major components:

(1) A 1/2-inch nominal pipe thread solenoid valve with brass body; 120 volt ac, 60 Hz service.

(2) A multirange timer mounted in a corrosion resistant fiberglass reinforced plastic enclosure with a momentary contact pushbutton and pilot light.

Solenoid valves were installed on the waterlines and the fiberglass enclosures mounted directly on the rinse tanks. The existing manual ball valves between the solenoid valves and the tank were left in place to provide for emergency shutoff if the overflow becomes plugged. The process flow is shown in Figure 2.

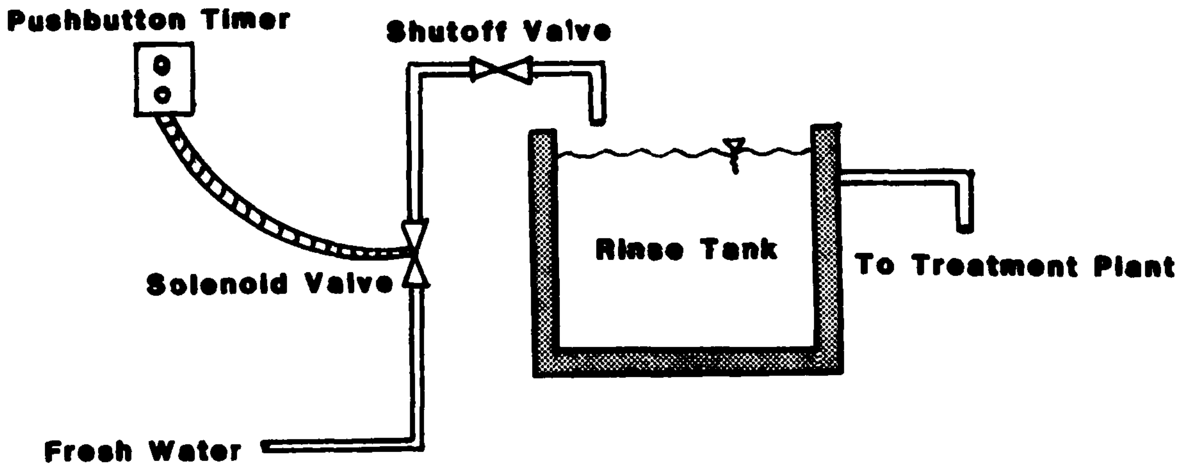


Figure 2. Process Flow Diagram.

## FLOW CALCULATION

Measuring actual dragout volume is practical only when large numbers of similar parts are plated. The intermittent nature of the military shops, however, lead to a wide variety of pieces. As a result, the minimum flowrates for the controllers were determined by calculating a "worst-case" dragout rate.

It is generally accepted that good rinsing can be achieved if the contaminant level is kept at or below 150 ppm (0.02 ounces/gallon). Using this number for the maximum acceptable concentration, and the assumed dragout rate, the required flow could be easily computed for any given plating solution. The timer setting can then be computed by dividing the

## SECTION IV

## TECHNICAL APPROACH

### SITE SURVEY

Although the SA-ALC plating shop is large, over 200 tanks, only 91 rinse tanks were being used during the survey (a full description of the tanks is contained in Appendix A). Although the shop operates 24 hours per day, the majority of the plating occurs during the day shift with only skeleton crews on the swing and night shifts.

Cyanide wastewater is collected separately from the other wastewaters in two 5000-gallon sumps. Any time these sumps fill, incoming water is shut off until the sumps can be emptied and taken to the IWTP for treatment. This limited capacity for cyanide waste, and resulting flow interuption, would have to be considered in the data evaluation from the project.

Rather than install 91 devices, only the 10 most frequently used tanks were evaluated for the demonstration. Flows to these tanks were measured to establish baseline data and eight were selected for installation of rinse controllers. The tank numbers, descriptions, and base flows are presented in Table 1.

**TABLE 1. RINSE TANKS SELECTED FOR THE DEMONSTRATION**

| Tank Number | Description | Flow Rate (gpm) |
|---|---|---|
| 128 | Cyanide Rinse | 7.9 |
| 133 | Cyanide Rinse | 4.7 |
| 419* | Acid Rinse | 4.2 |
| 425 | Acid Rinse | 8.5 |
| 526 | Cyanide Rinse | 9.6 |
| 616 | Cyanide Rinse | 11.2 |
| 634 | Cyanide Rinse | 6.3 |
| 638* | Acid Rinse | 9.4 |
| 640 | Acid Rinse | 14.4 |
| 711 | Cyanide Rinse | 2.1 |
| Total flow for the eight tanks: | | 64.7 |
| Average flow for the eight tanks: | | 8.1 |

*Not selected for testing. Tank 419 had a conductivity cell installed.

TABLE 3. MAXIMUM RINSE WATER CONDUCTIVITIES

| Tank Number | Process Solution | Allowable Conductivity (in mho) |
|---|---|---|
| 128 | Cleaner, light duty | 230 |
| 133 | Cleaner, heavy duty | 450 |
| 425 | Sodium Hydroxide | 690 |
| 526 | Cadmium (Cyanide) | 260 |
| 616 | Chromic Acid | 450 |
| 634 | Copper Cyanide Strike | 320 |
| 640 | Nickel | 128 |
| 711 | Zinc (Cyanide) | 280 |

These tanks were selected because of their frequency of use vs. their flow rates. Hence, the 8.1 gpm flow rate does not represent the average flow for the 91 rinse tanks in use during the demonstration. Given the total flow from the plating shop, 325,000 gallons per day, these tanks are below the tank average for the shop which makes the estimate of water savings from this demonstration more conservative.

Because the demonstration involved only a fraction of the total rinse tanks and the intermittent shutdown of the water because of the cyanide wastewater sumps, flow rates on the selected tanks were used as criteria to evaluate the system performance instead of total wastewater generation. In addition, electric clocks were installed at each rinse station to record how long the flows were activated. These times, along with the timer settings, made it possible to determine the frequency of use for each tank. The final flowrates, timer settings, and frequency of tank use are shown in Table 2.

TABLE 2. POSTINSTALLATION FLOW RATES AND TIMER SETTINGS

| Tank Number | Flow Rate (gpm) | Timer Setting (min) | Times Used/Day |
|---|---|---|---|
| 128 | 5.6 | 4.5 | 22 |
| 133 | 2.7 | 20 | 20 |
| 425 | 13.6 | 4.6 | 2 |
| 526 | 8.5 | 7.1 | 29 |
| 616 | 7.5 | 8.0 | 3 |
| 634 | 7.5 | 8.7 | 9 |
| 640 | 8.1 | 4.0 | 3 |
| 711 | 1.2 | 23 | n/a* |
| | Average Flow | 6.8 gpm | |

*Data not available due to clock malfunction.

## DATA COLLECTION

During testing there were times when the water was turned off due to the cyanide sumps being full. To allow for this water interruption rinsewater conductivity measurements were taken to verify the accuracy of the clock readings. If the timer indicated the rinse controller had been activated and there was a rise in conductivity, meant the water had been shut off and the recorded times would be valid. Conversely, if the clock showed the system had not been activated, and there was an increase in conductivity, it meant that the operator had failed to activate the system.

The conductivity measurements also were used to monitor rinse tank contaminant levels. These limits, presented in Table 3, were exceeded only once during the demonstration when the system had not been for an entire shift.

## SECTION V

## CONCLUSIONS

### FEASIBILITY

Manually activated timer rinse controllers are capable of reducing the water consumption at military plating shops. They are simple to operate and maintain, require little maintenance, and are applicable to any running rinse tank. Interviews with the platers indicated a very favorable response to the controllers and many stated they felt they were doing more to save money (water) for the shop. Although the demonstration was successful from an operational standpoint, the periodic shutdowns of feedwater and relative low baseline water use at SA-ALC made the projections for water savings artificially low. In general, the savings at other facilities would probably be much higher.

### COST/PAYBACK

The controllers for SA-ALC cost $467 each and were installed by contract for $546 each. These costs were relatively high because the eight tanks selected for the demonstration were spread throughout the shop, thus, increasing installation cost. In addition, had military electricians and plumbers been used to install the controllers, the costs would have been cut considerably.

The controllers reduced the water consumption on the demonstration tanks by 71 percent. Assuming approximately 20 percent of the tanks would not be used enough to warrant installation, this leads to a potential water savings of nearly 2 million gallons per year. Again, due to the installation cost, the payback period, 6.6 years, would not be economical for SA-ALC; however, this shop is the exception rather than the rule. Most plating shops use many times that much water; 200,000 gallons per day is not uncommon. In these cases, or if an IWTP is approaching its maximum flow, this rinse control system could be applicable.

### RECOMMENDATIONS

Although the application is site-specific, the timer rinse controllers are a viable, economical method for reducing water consumption in plating operations. Figure 3 illustrates the annual water cost savings for a facility using 2.4 million gallons of water per year (i.e., $5.50/1000 gallons=$13,200 per year). The potential savings from a timed rinse controller system is $9,400.

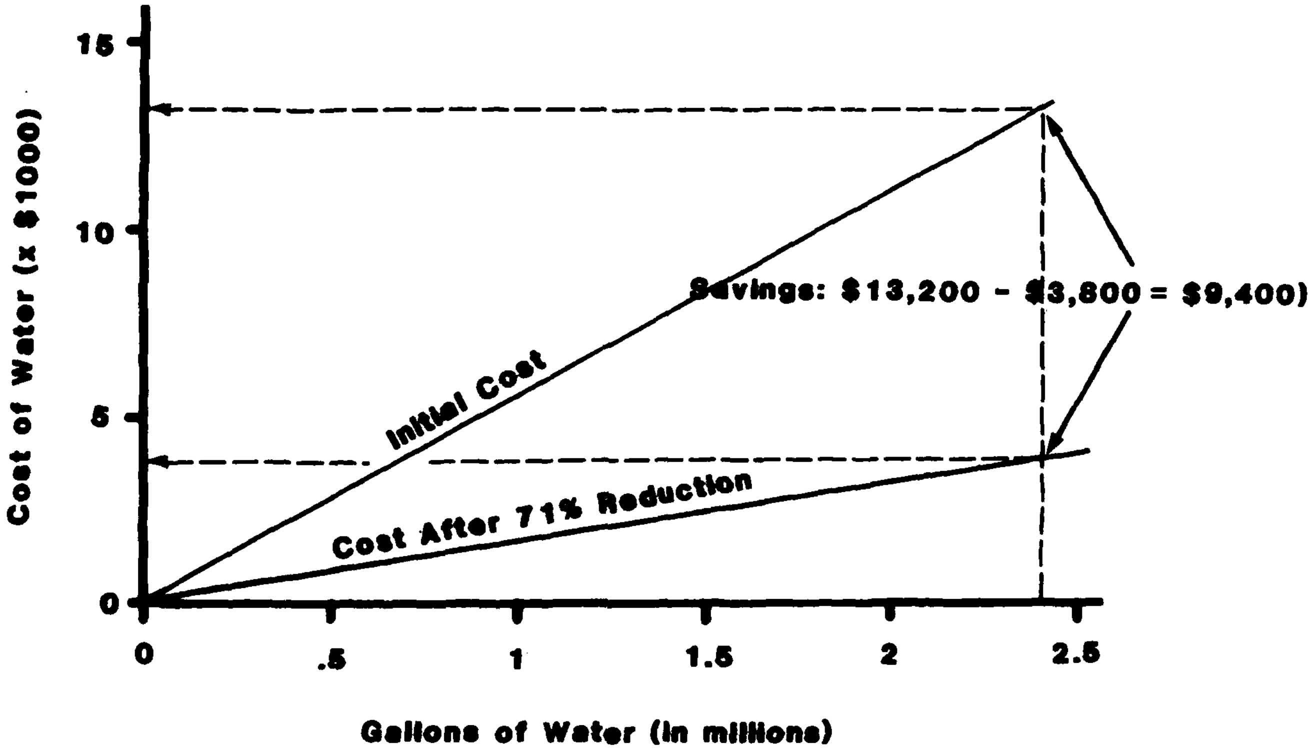


Figure 3. Potential Savings from Timer Rinse Controllers

This analysis can be taken one step further and turned into a predictive model. Using the installed cost from this project, $1000 per tank, and the 71 percent water savings ( $5.50 per 1000 gallons) of water, the plot shown in Figure 4 can be generated.

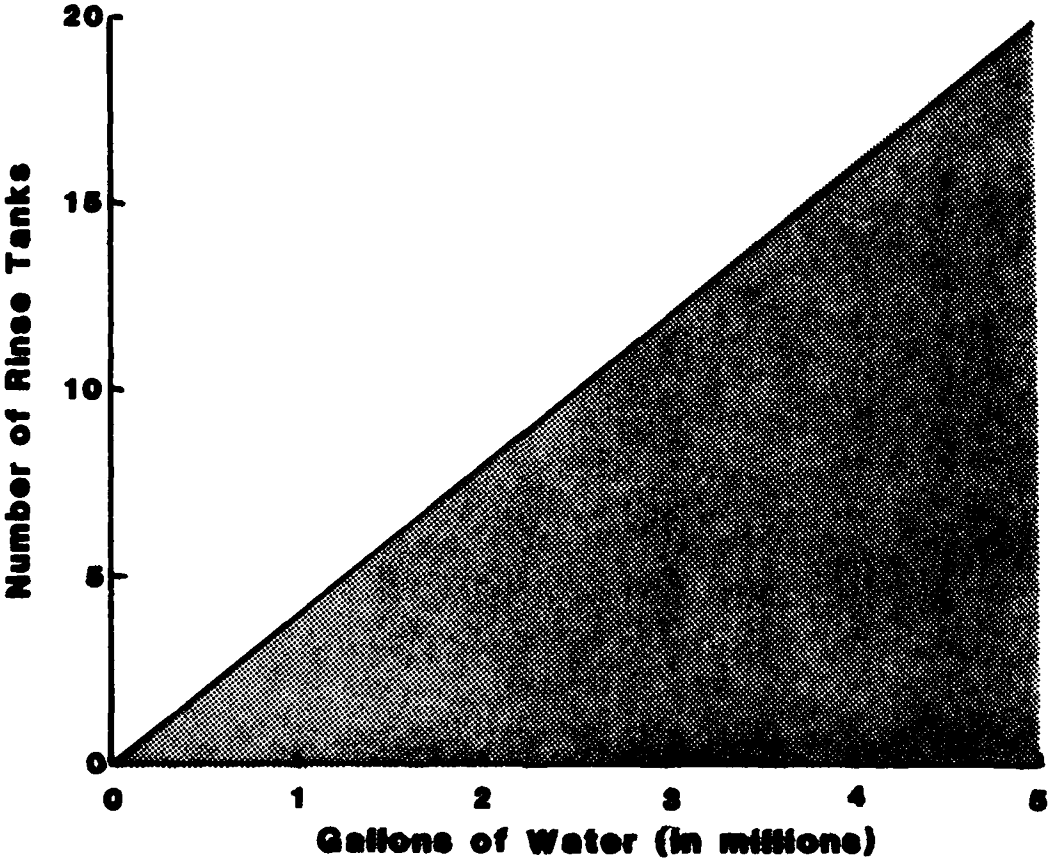


Figure 4. Feasibility Model for Applying Timed-Rinse Controllers

To use the graph in Figure 4 you need only three figures. First, the number of running rinse tanks in the shop; second, the annual water consumption of the shop; and finally, a target payback period for the investment in rinse controllers. For example, a shop operating 8 hours a day, 300 days a year, with 5 rinse tanks using 3 gpm would use 4.3 million gallons of water per year. If a target payback period of 1 year is selected, enter the graph at 4.3 million on the X axis and 10 tanks on the Y axis. The intersection of the line is in the shaded area of the curve which indicates that the system could potentially payoff and warrants consideration. Likewise, if a 2-year payback was selected, then the X coordinate would be 8.6 million gallons. Figure 5 shows the same plot (i.e., y = 4x) for use by a larger shop.

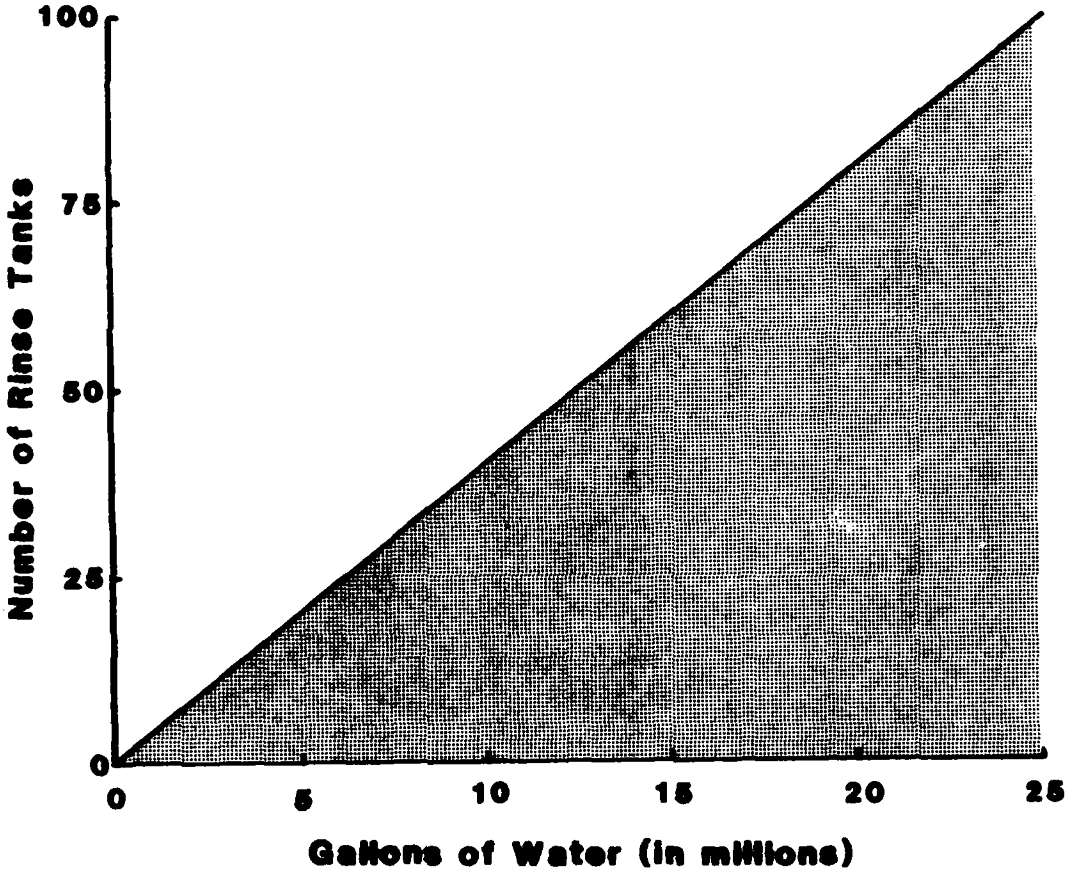


Figure 5. Feasibility Model for Applying Timed-Rinse Controllers for Larger Plating Shops

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1. Roberts, C.G. and Cushnie, G.C, "An Investigation of Technologies for Hazardous Sludge Reduction of AFLC Industrial Waste Treatment Plants," August 83.

2. U.S. Environmental Protection Agency, "Environmental Pollution Control Alternatives: Economics of Wastewater Treatment Alternatives for the Electroplating Industry," IERL, Cincinnati, Ohio, Jun 79, pp 33-34.

3. Mohler, J. B., "Dual Purpose Rinsing," Plating and Surface Finishing, Sep 79, p 49.



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# APPENDIX A

## SA-ALC PLATING SHOP TANK SCHEDULE

TABLE A1. KELLY AFB PLATING SHOP TANK SCHEDULE

| Tank Number | Description | Tank Number | Description |
|---|---|---|---|
| 101 | Cyanide waste holding | 211 | Nital etch |
| 102 | Cold rinse (CN) | 212 | Hot rinse |
| 103 | Amonium Nitrate | 301 | Alkaline rust remover |
| 104 | Cold rinse | | |
| 105 | Anodize strip | 302 | Hot rinse |
| 106 | Cold rinse | 303 | Non etch cleaner |
| 107 | Hot rinse | | |
| 108 | Chrome strip | 304 | Cold rinse |
| 109 | Cold rinse | 305 | Chrome pickle |
| 110 | NiCd strip | 306 | Cold rinse |
| 111 | Cold rinse (CN) | 307 | Ammonium biflouride |
| 112 | Anode cleaner | | |
| 113 | Cold rinse (Cr) | 308 | HF |
| 114 | Lead strip | 309 | Cold rinse |
| 115 | Alpac strip (lead strip) | 310 | Deoxidizer |
| 116 | Cold rinse (acid) | 311 | Cold rinse |
| 117 | Cyanide rinse | 312 | Dow 19 |
| 118 | Paint strip | 313 | Cold rinse |
| 119 | Nitric acid in barrels | 314 | Chrome recovery evap |
| 120 | Cold rinse | | |
| 121 | Ni strip (nitric acid) | 315 | Cold rinse |
| 122 | Acid cold rinse | 316 | Dichromate Dow 7 |
| 123 | Cu strip | | |
| 124 | Cold rinse | 317 | Cr acid anodize |
| 125 | Hot rinse | | |
| 126 | Ni strip (CN) | 318 | Cold rinse |
| 127 | Ni strip (CN) | 319 | Hot rinse |
| 128 | Cold rinse (CN) | 320 | Perc/tet degreaser |
| 129 | Ag strip (CN) | | |
| 130 | Cold rinse (CN) | 320-A | Nitric acid |
| 131 | Alkaline Cr strip | 321 | Cold rinse |
| 132 | Alkaline Cr strip | 322 | Alodine |
| 133 | Cold rinse (CN) | 323 | Cold rinse |
| 134 | Hot rinse (CN) | 324 | Sulfuric acid anodize |
| 201 | Non etch cleaner (alkaline) | | |
| 202 | Cold rinse | 325 | Hardcoat anodize |
| 203 | Deoxidizer | | |
| 204 | Cold rinse | 326 | Cold rinse |
| 205 | Alodine coat | 327 | Dichromate sealer |
| 206 | Cold rinse | | |
| 207 | Empty | 328 | Cold rinse |
| 208 | Chrome holding | 329 | Black dye bath |
| 209 | Cr acid holding | 401 | Alkaline cleaner |
| 210 | Cold rinse | | |

TABLE A1(Continued)

| Tank Number | Description |
|---|---|
| 402 | Cold rinse |
| 403 | Cr acid hold |
| 404 | Cold rinse |
| 405 | Cr acid etch |
| 406 | Cr plate |
| 407 | Cr plate |
| 408 | Cr plate |
| 409 | Cr plate |
| 410-A | Ammonium biflouride sulfuric acid |
| 410-B | Cr plate stainless |
| 411 | Ammonium biflouride |
| 412 | Cold rinse |
| 413 | Cr plate |
| 414 | Cr plate |
| 415 | Cr plate |
| 416 | Cr plate |
| 417 | Cr plate |
| 418 | Cr still rinse |
| 419 | Cold rinse |
| 420 | Sodium hydroxide |
| 421 | HCl solu. |
| 422 | Cr plate |
| 423 | Cr plate |
| 424 | Cr plate |
| 425-A | Still rinse |
| 425-B | Cr rinse |
| 501 | Cold rinse |
| 502 | Alkaline cleaner |
| 503 | Cold rinse |
| 504 | HCl |
| 505 | Cold rinse |
| 506 | Sulfuric acid |
| 507 | Cold rinse |
| 508 | Ni strike |
| 509 | Cold rinse |
| 510 | Electroless Ni Series |
| 511 | Electroless Ni |
| 512 | Electroless Ni |
| 513 | Electroless Ni |
| 514 | Electroless Ni |
| 515 | Electroless Ni |
| 516 | Electroless Ni |
| 517 | Cold rinse |
| 518 | Hot Rinse |

| Tank Number | Description |
|---|---|
| 520 | Nitric acid leach. solu. |
| 521 | Cold rinse |
| 522 | Nitric acid pass. solu. |
| 523 | Electroless Ni |
| 524 | Cold rinse |
| 525 | Cd plate (CN) |
| 526 | Cold rinse |
| 527 | Conversion coat |
| 528 | Hot rinse |
| 601 | Cold rinse |
| 602 | Phosphate type 2 |
| 603 | Cr acid |
| 604 | Cold rinse |
| 605 | Black oxide |
| 606-A | Black oxide |
| 606-B | Black oxide |
| 607 | Hot rinse |
| 608 | Alkaline cleaner |
| 609 | Cold rinse |
| 610 | HCl |
| 611 | Cold rinse |
| 612 | Ni strike |
| 613 | Cold rinse |
| 614 | Cd plate (CN) |
| 615 | Cd plate (CN) |
| 616 | Cold rinse(CN) |
| 617 | Chromate conversion |
| 618 | Cold rinse (acid) |
| 619 | Hot rinse |
| 620 | Chem. milling solu.- NaOH |
| 621 | Cold rinse |
| 622 | Nitric acid |
| 623 | Cold rinse (acid) |
| 624-A | Removed |
| 624-B | Removed |
| 625 | Acid cold |
| 626 | Zincate |

TABLE A1 (Concluded)

| Tank Number | Description | Tank Number | Description |
|---|---|---|---|
| 627 | Cold rinse | 720 | Empty |
| 628 | LTA plate | 722 | Empty |
| 629 | Cold rinse | 723 | Hi speed Ag plate |
| 630 | Bronze plate | | |
| 631 | Cold rinse (CN) | 724 | Hi speed Ag plate |
| 632 | Hot rinse | | |
| 633-A | 50% Nitric acid | 725 | Empty |
| 634 | Cyanide rinse | 726 | Cold rinse(CN) |
| 635 | HCl etch | 727 | Cold rinse(CN) |
| 636 | Cold rinse | 728 | Cold rinse(CN) |
| 637 | Ni strike | 729 | Hot rinse(CN) |
| 638 | Cold rinse | 730 | Au plate |
| 639 | Ni plate | 731 | Cold rinse(CN) |
| 640 | Cold rinse (acid) | 801 | Cold rinse |
| 641 | Ni plate | 802 | Scale Condition |
| 642 | Cold rinse | | |
| 643 | Covered w/ plastic | 803 | Cold rinse |
| 644 | Cold rinse | 804 | Nitric etch |
| 645 | Lead plate | 805 | Cold rinse |
| 646 | Empty | 806 | HCL etch |
| 647 | Rinse (acid) | 807 | Rochelle salt |
| 702 | Alkaline cleaner | 808 | Cu strike |
| 703 | Cold rinse (acid) | 809 | Cold rinse |
| 704 | Sulfuric acid | 810 | Electroless Ni |
| 705 | Cold rinse (acid) | 811 | Cold rinse |
| 706 | Cold rinse (acid) | 818 | Cold rinse |
| 707 | Cold rinse (acid) | 819 | Vitro cleaner |
| 708 | Ni | 900 | Area of plant permanently shut down |
| 709 | Cold rinse (acid) | | |
| 710 | Cu strike | | |
| 711 | Cold rinse (CN) | | |
| 712 | Ag strike | | |
| 719 | Cold rinse | | |

## APPENDIX B

## MISCELLANEOUS DATA/CALCULATIONS

TABLE B-1. ANALYTICAL DATA

Grab Samples from the Two Acid Rinse Tanks

| Tank Number | Date | Time | Sample ID Number | Metal | Conc., mg/1 |
|---|---|---|---|---|---|
| 425 | 2/26/85 | 3:30 PM | K-022685-1 | Cr | 1.24 |
| 640 | 2/26/85 | 3:30 PM | K-022685-2 | Ni | 37.04 |
| 425 | 2/27/85 | 3:30 PM | K-022785-1 | Cr | 1.15 |
| 640 | 2/27/85 | 3:30 PM | K-022785-2 | Ni | 31.96 |
| 425 | 2/28/85 | 3:00 PM | K-022885-1 | Cr | 1.10 |
| 640 | 2/28/85 | 3:00 PM | K-022885-2 | Ni | 33.98 |

Table B-2. CONDUCTIVITY MEASUREMENTS, mho

| Tank Number | 2/25/85 10:30 AM | 2/26/85 7:30 AM | 2/26/85 3:30 AM | 2/27/85 7:30 AM | 2/27/85 3:45 PM | 2/28/85 7:30 AM | 2/28/85 12:15 PM |
|---|---|---|---|---|---|---|---|
| 128 | 15 | 95 | 245 | 238 | 272 | 205 | 220 |
| 133 | tank empty | 18 | 20 | 92 | 88 | 91 | 85 |
| 425 | 15 | 18 | 20 | 18 | 19 | 19 | 20 |
| 526 | 212 | 122 | 375 | 500 | 720 * | 1180 * | 1000 * |
| 616 | 165 | 235 | 255 | 270 | 300 | 260 | 300 |
| 634 | 155 | 165 | 185 | 175 | 205 | 170 | 180 |
| 640 | 71 | 75 | 98 | 88 | 98 | 103 | 110 |
| 711 | 35 | 82 | 90 | 90 | 123 | 103 | 115 |

* Clock readings indicated that the operator was failing to activate the timer on the night shift. High tank usage, low timer setting, and shutdown of CDT water system contributed to rapid rise in contaminant level.

TABLE B-3. CALCULATION OF WATER SAVINGS

| Tank Number | A Original Flow Rate gal/min | B Adjusted Flow Rate gal/min(a) | C C=Bx8 h/d Flow/day gal(b) | D New Flow Rate(c) gal/min | E Frequency of Use, no. Times/day | F Timer Setting min/times | G G = D x E x F Total Flow gal/day |
|---|---|---|---|---|---|---|---|
| 128 | 7.8 | 4.0 | 1920 | 5.6 | 22 | 4.5 | 554 |
| 133 | 4.7 | 2.4 | 1152 | 2.7 | 20 | 20 | 1080 |
| 425 | 8.5 | 4.3 | 2064 | 13.6 | 2 | 2 | 125 |
| 526 | 9.6 | 4.8 | 2304 | 8.5 | 29 | 29 | 1750 |
| 616 | 11.2 | 5.6 | 2688 | 7.5 | 3 | 3 | 180 |
| 634 | 6.3 | 3.2 | 1536 | 7.5 | 9 | 9 | 587 |
| 640 | 14.4 | 7.2 | 3456 | 8.1 | 3 | 3 | 97 |
| 711(d) | - | - | - | - | - | - | - |
| TOTALS | | | 15,120 | | | | 4373 |

$$\text{Percent reduction} = \frac{15{,}120 \text{ gal/d} - 4373 \text{ gal/day}}{15{,}120 \text{ gal/day}} \times 100 = 71\%$$

a Original flow rates were measured with valves wide open and adjusted by multiplying by 0.50 to account for some values being throttled part way.

b Flow per day calculated on 8 hour water system operation per day.

c After installation of solenoid valves

d Tank 711 eliminated from test due to malfunction of electric clock used to collect data.

# APPENDIX C

# OPERATING MANUAL

# APPENDIX C

## RISON RINSE CONTROLLER

## INSTALLATION AND OPERATING INSTRUCTION MANUAL

Supplied by:
Rison, Inc.
P.O. Box 1916
Leesburg, VA 22075

(Note: This manual was supplied by Rison, Inc., and is printed as submitted. Reference to the manufacturer does not suggest endorsement.)

TABLE OF CONTENTS

## Principle of Operation

The cost of water has risen rapidly over the past ten years. In most areas a sewage surcharge several times the water cost is added to the water bill to cover the expense of treating the contaminated wastewater. In the electroplating industry, the entire wastewater flow must be treated prior to discharge to remove undesirable chemicals. In order to keep these cost factors at a minimum, the water used for rinsing in a plating shop must be kept at a minimum.

Several devices, such as flow restrictors and conductivity controllers, have been developed to control the quantity of rinse water used. Each has proven to be effective in reducing flows but have produced maintenance problems. Flow restrictors change flow characteristics with time, tend to trap particles in the water lines, and waste water when production is interrupted. Conductivity controllers are susceptible to deterioration of the sensor probe and the mineral content of the water supply.

The Rison Rinse Controller provides rinsewater very close to the minimum required to produce an acceptable product. The quantity of water used is BASED UPON THE PRODUCTION RATE. The flow of water is stopped during production interruptions, coffee breaks, lunch periods, etc.

The components of the Rinse Controller are a timer, a solenoid valve, and an actuating device (pushbutton, limit switch, etc.). All these components have been proven reliable and trouble free in millions of applications. The components are housed in corrosion-proof enclosures to withstand the plating shop environment.

## RINSING REQUIREMENTS

Many studies have been conducted to determine just what quantity of water is required in the various rinsing operations in a plating shop. These rinsing steps follow cleaning and surface preparation, plating, and postplating treatment (e.g. chromating). The dragout from each of these operations must be diluted with fresh water to avoid contaminating the following bath or avoid staining the parts being plated.

The allowable rinse tank concentrations consistent with good quality work have been determined as follows:

TABLE A-1
ALLOWABLE RINSE WATER CONCENTRATIONS

| Type of Rinse | Application | Average g/l | Concentration oz/gal |
|---|---|---|---|
| Intermediate | metal preparation | 3 | .33 |
| Final | functional | 0.7 | 0.09 |
| Final | bright | 0.03 | 0.004 |

If the dragout per rack is known, the amount of rinse water required to dilute that dragout to the allowable rinse tank concentration can be calculated:

$$\text{Rinse Water Required} = \frac{\text{Process tank Conc x Dragout Rate/Rack}}{\text{Allowable Rinse Tank Concentration}}$$

The rinse water required divided by the water flow rate in the rinse tank gives the time the water must be turned on per rack. The pushbutton/timer/solenoid combination provides the means for controlling this flow.

## INSTALLATION

1. Install the solenoid valve in the inlet water line supplying the rinse tank. Be sure to note the direction of flow indicated on the valve.

2. Mount the Rinse Controller control box in a location convenient to the operator.

3. Connect the 120 volt supply to the control box and the wiring to the solenoid valve according to the wiring diagram.

## SETTING THE TIMER

1. Determine the maximum drag-out per rack (piece, barrel, etc.). Procedures for determining the dragout are given in these instructions.

2. Measure the water flow rate into the rinse tank by following the procedure given in these instructions.

3. Select the allowable rinse concentration from Table 1 if not otherwise mandated by procedural manuals, etc.

4. Determine the timer setting using the following example as a guide.

EXAMPLE: The dragout from a bright zinc cyanide plating bath with a concentration of 4.0 oz/gal is 1 quart (.25 gal) per hour at a production rate of 20 racks/hour. The water flow into the following rinse tank is 5 gal/min. What is the proper timer setting?

Solution: The dragout rate/racks is 0.25 gallon divided by 20 racks/hr or 0.0125 gal/rack. Using the above formula, the rinse water required is:

Rinse Water Required =

$$\frac{4 \text{ oz/gal} \times 0.0125 \text{ gal/rack}}{0.004 \text{ oz/gal}} = 12.5 \text{ gal/rack}$$

Therefore the timer setting is:

$$\frac{12.5 \text{ gal/rack}}{5 \text{ gal/min}} = 2.5 \text{ min/rack}$$

5. Set the timer for the approximate time calculated in Step 4.

Note: The timers supplied with the Rison Rinse Controller can be set for one of three time ranges: 0-1 minutes, 0-10 minutes, and 0-100 minutes by moving a jumper plug on the back of the timer. The range is factory set at 0-10 minutes unless otherwise specified. Refer to the timer instruction manual supplied with this manual to change the timer range.

## DETERMINING DRAGOUT RATE

The dragout rate from a plating tank can be determined by first draining and thoroughly cleaning the first rinse tank following the bath. The tank is then filled with fresh water to the overflow line and the water is turned off. Then a fixed number of racks are plated and passed through the rinse. The rinse is thoroughly mixed to assure uniformity. A sample is taken of the rinse water and the plating tank and is analyzed for the metal being plated. The dragout is then calculated as follows:

$$\text{Volume of dragout per rack} = \frac{\text{Conc. rinse tank} \times \text{Volume rinse tank}}{\text{Conc. plating tank} \times \text{Number of racks}}$$

## DETERMINING RINSE WATER FLOW

Note that the solenoid valve should be installed on the water line before the flow is measured.

If the inlet water line to the rinse tank is conveniently placed, the water flow can be determined by setting the timer at a high value so that it does not interrupt the flow measurement. Hold a 5 gallon pail under the inlet line and push the rinse controller pushbutton. With a stopwatch, record the time required to fill the pail.

A more accurate method is to drain some of the water from the rinse tank and measure the distance from the water surface to the overflow. The volume required to fill the tank is then calculated. By timing the flow until the water just reaches the overflow line, the flow rate can be calculated.

RINSE CONTROLLER

MODEL RC1-1

PARTS LIST

| Item | Description |
|---|---|
| Enclosure | Crouse Hinds # HJB050905 |
| Timer | ATC # 344A360020X |
| Solenoid Valve | Asco # 8211D2 |
| Pilot Bulbs # 120PSB | General Electric or Sylvania |

The above items can be ordered from the manufacturers listed or from:

RISON, INC.
P.O. Box 1916
Leesburg, VA 22075

Please state model and serial number when ordering.

# 344 BR1X TDR

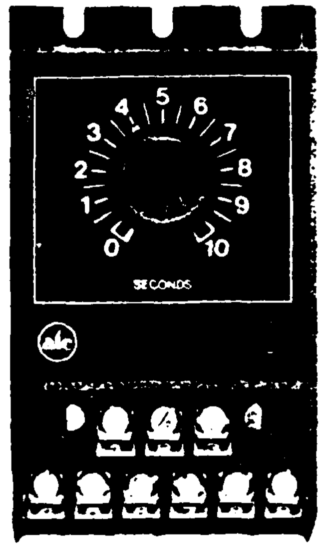
INSTALLATION INSTRUCTIONS
JANUARY 1984

**DESCRIPTION:**

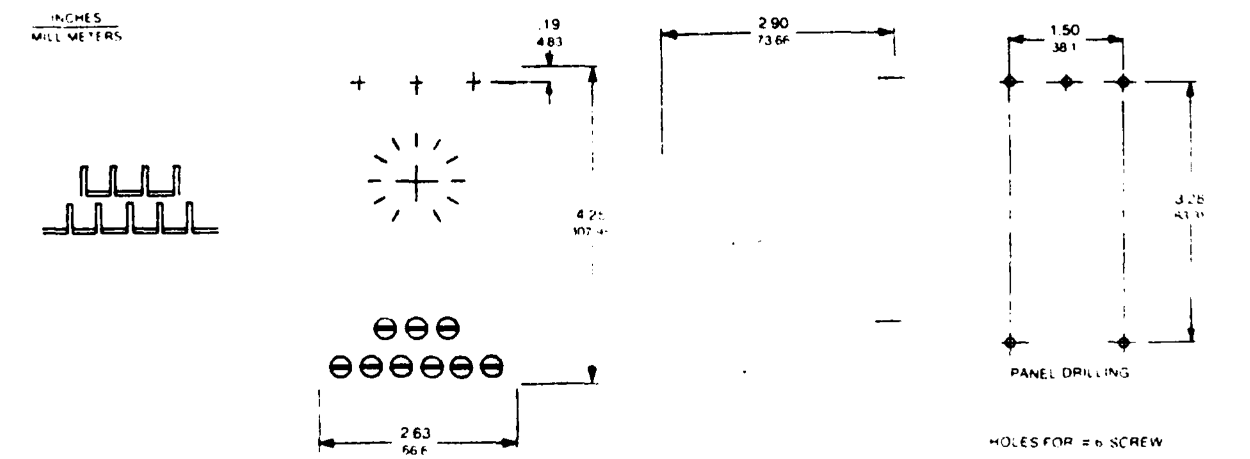
The ATC 344 is available in an off-delay (delay-on-break) model and a programmable on-delay/interval model. The off-delay model employs a 3 wire start circuit(L1, L2 and start) to allow start on break of a contact. The unit does not provide memory retention on power failure.

The on-delay/interval model is normally used in the on-delay mode; programming to interval mode would allow use in a momentary start circuit. The interval mode also allows duplication of some circuits normally employing an instantaneous contact when used in series (XOX or OXO) with a delayed contact.

Both are fully adjustable multi-range timers, available in a choice of 1/10/100 seconds or minutes.




**DIMENSIONS:**



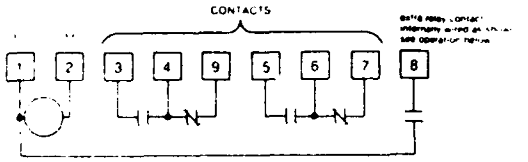

**MOUNTING:**

The unit is designed for surface mounting only; it does not panel mount.

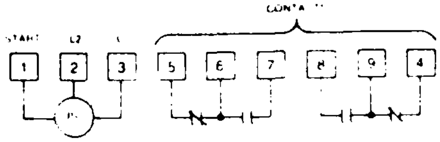
It is not position sensitive and can be mounted on any flat surface. Using the unit as a template, mark, drill and tap for #6 screws

**WIRING:**

ON DELAY/INTERVAL

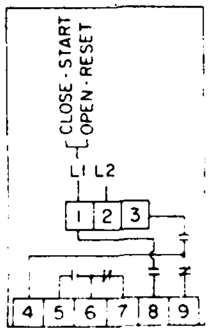



OFF DELAY

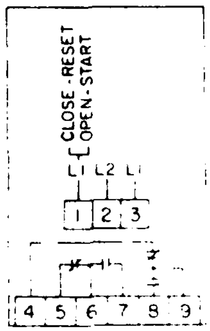



**TERMINAL WIRING:**

ON DELAY/INTERVAL




OFF DELAY




OPERATION:

**On Delay/Interval Model**

Timing begins when the start switch is closed. In **on-delay** operation, the relay is energized at end of timing. In ***interval*** mode the relay energizes at start of timing and releases at timeout. In either mode, reset is accomplished when the start switch is open. The pilot light is on during timing.

**Note** that an extra relay contact (SPST) is wired between terminal 1 and 8 on the on delay/interval unit. In the ***interval*** mode, use this contact as a lockup for a momentary start. Or, it can be used as another output in either mode. In ***interval*** mode contact action is OXO. In **on-delay** mode contact action is OOX.

**Off Delay Model**

With power applied and the start switch closed, the timer is in the reset condition with the relay energized. Timing begins when the start switch is open. At timeout, the relay deenergizes, reclosing the start switch resets the timer. Pilot light is on during timing.

ON DELAY

OFF DELAY

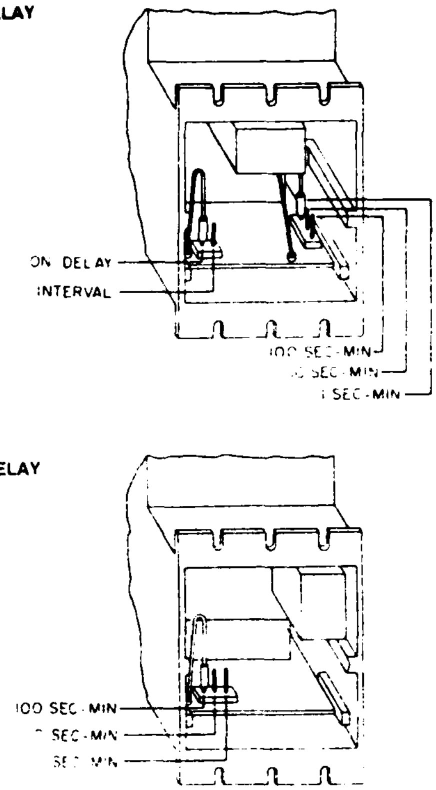



*Figure 1*

**CHANGING THE RANGE:**

The 1, 10 and 100 second range model will come factory set in the 10 second range.

The 1, 10 and 100 minute range model will come factory set in the 1 minute range.

To change range:

**A.** Remove the knob with a small .50" Allen wrench

**B.** Remove the retaining nut, then the exposed scale and replace with proper scale for range intended.

**C.** Position pot shaft at minimum (ccw) setting; replace knob, aiming pointer at the heavy reference line at zero mark. Tighten Allen screw.

**D.** Set range programming jumper per Figure #1.

**PROGRAMMING ON DELAY/INTERVAL:**

Position the jumper (shown also on the nameplace label) per Figure 1

---

**SPECIFICATIONS:**

**MODELS**
Choice of two
On-Delay/Interval (programmable)
Off-Delay (delay-on-break)

**RANGES**
Choice of two programmable multi-range models.
1, 10 and 100 sec
1, 10 and 100 min
All ranges are fully dial-adjustable

**REPEAT ACCURACY**
Varies as a function of line voltage and temperature but not of reset time*.
± 1% of setting or 2.0 msec when temperature is constant and line voltage is constant but within limits**
± 1% of setting or 2 ms when temperature is constant and voltage varies within limits (on delay mode interval and off delay ± 3%)
± 8% of setting or 2.0 msec when line voltage is constant and temperature varies within limits**
± 8% of setting or 2.0 msec when line voltage and temperature vary within limits**

*Reset time must be at least 100 ms for on delay or off delay modes. 275 ms for interval mode
**Line voltage must be within + 10% -15% of 120V nominal (NEMA standard) and temperature between 0°-65°C (32°-150°F)

**SETTING ACCURACY**
± 10% at full scale

**EFFECTS OF RESET DURING TIMING AND POWER INTERRUPTION DURING TIMING**
ON DELAY: Power interruptions during timing greater than 100 ms cause a new timing cycle to be initiated.

OFF DELAY: Power interruptions during timing between 2.5 ms and 100 ms will cause the relay to deenergize for the duration of the interruption, but will not abort the cycle. Interruptions longer than 100 ms will cause immediate time-out.

Reset pulses (start contact closings) applied during timing shorter than 200 ms will be ignored. Pulses longer than 500 ms will cause a new cycle to be initiated. Results of pulses between 200 ms and 500 ms is indeterminate.

INTERVAL: Power interruptions between 2.5 ms and 10 ms will cause the relay to deenergize for the duration of the interruption. Interruptions between 10 ms and 150 ms will cause immediate time-out in the 1 sec range and shortened cycle time in the longer ranges. Power interruptions longer than 150 ms will cause a new timing cycle to be initiated.

**LOAD RELAY**
TYPE: DPDT, hard-wired
LIFE: 50,000,000 operations (no load)
CONTACT RATING: 7A resistive at 120 or 240V
1/6 HP at 120V

**POWER REQUIREMENTS**
120V AC 95 to 132V, 50/60 Hz, 0.02A
240V AC 190 to 264V, 50/60 Hz, 0.02A
24V AC 21 to 28V, 50/60 Hz, 0.015 A

**TEMPERATURE RATING**
0 to 70°C (32 to 158°F)

**TERMINALS**
9 front-facing saddle clamp screw terminals

**HOUSING**
Impact-resistant molded plastic case for surface mounting

**WEIGHT**
NET 7 oz 196 gm
SHIPPING 10 oz 280 gm

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**ORDERING CODE** 344A 358 Q 13 X

**BASIC TYPE** — 344A

**RANGE** — 358

| | |
|---|---|
| 358 | Programmable multi-range 1,10 100 sec |
| 360 | Programmable multi-range 1 10 100 min |

**VOLTAGE AND FREQUENCY** — Q

| | |
|---|---|
| Q | 120/50/60 |
| R | 240/50/60 |
| T | 24/50/60 |

**ARRANGEMENT** — 13

| | |
|---|---|
| 13 | On delay/interval (programmable) |
| 20 | Off delay |

**FEATURES** — X

| | |
|---|---|
| X | Standard |
| K | Special |

**AUTOMATIC TIMING & CONTROLS CO.**
KING OF PRUSSIA, PENNSYLVANIA 19406
Phone (215) 337 5500 Telex 84 6437

Printed in U.S.A.



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